CONVENTION ON INTERNATIONAL TRADE IN ENDANGERED SPECIES
OF WILD FAUNA AND FLORA

Twelfth Meeting of the Conference of the Parties
Santiago (Chile), November 3-15, 2002

Interpretation and Implementation of the Convention

TRADE IN SEA CUCUMBERS IN THE FAMILIES HOLOTHURIDAE AND STICHOPODIDAE

This document has been submitted by the United States of America.

Introduction and Purpose of this Discussion Paper

Sea cucumbers, especially of the families Holothuridae and Stichopodidae, form an important part of a multi-species invertebrate fishery that has been in existence in the Indo-Pacific for traditional and subsistence uses, but have expanded since the late 1980s to supply growing international markets with bêche-de-mer, a luxury food item, and also organisms for aquaria and biomedical research. Trends in the fishery indicate that the number of producing countries and species in trade have recently increased worldwide, both in tropical and temperate regions, and holothurian fisheries have spread to many non-traditional fishing areas such as Mexico, the Galapagos and North America during the 1990s. For instance, Hong Kong Special Administrative Region (Hong Kong SAR) import statistics show an increase from 25 source countries in 1987-1989 to 49 countries that exported bêche-de-mer in 2000-2001. The total trade in holothurians increased substantially in the late 1980s, and by 1995 reached a global annual volume of over 13,000 metric tons, valued at about US $ 60 million (Jaquemet and Conand, 1999). Nevertheless, available trade data may represent an underestimate of the total global commerce, as trade routes for holothurians are complicated, export data are incompletely reported, and commodities in trade can include several forms of dried product as well as chilled, frozen and salted bêche-de-mer. Bêche-de-mer is primarily exported from producer countries to a central market in Hong Kong SAR, Singapore or Chinese Taipei, and then re-exported to Chinese consumers worldwide (Conand and Byrne, 1993).

The general life-history traits of this group of invertebrates suggest that they constitute fragile stocks. Holothurians are extremely vulnerable to over-exploitation due to their late maturity, density-dependent reproduction, low survival of larvae, and ease of collection by humans. Over the last two decades, many of the high value species have been overexploited in much of Southeast Asia and Indo-Pacific islands to meet a growing demand and international trade to supply Asian markets. A marked increase in landings and export of holothurians, combined with a limited amount of fishery data, a paucity of biological information and population parameters for commercially important species, and the existence of few management measures, are all factors contributing to the decline of holothurian populations (Conand and Byrne, 1993).

Biological and trade information strongly suggest that sea cucumbers may qualify for listing in Appendix II of CITES. Given the past and continuing levels of exploitation to meet international demand, these species meet criteria in Resolution Conf. 9.24 Annex 2a Bi). Of critical importance to the debate is whether a CITES listing can contribute to the sustainable management of sea cucumbers. A number of issues have to be addressed before this question can be answered, including taxonomic uncertainties within the families, ability to distinguish taxa in the form they are traded, adequacy of biological information for making non-detriment findings, and ability to make legal acquisition findings. The intent of the United States in requesting that this issue be discussed by the Conference of Parties is to address the fundamental questions of whether CITES listing is appropriate for and can contribute to the conservation of sea cucumbers. To address this, we believe it is important to: (1) establish dialogue between Parties, scientists, industry and communities dependent on these resources; (2) encourage continued research to clarify taxonomy and identification of live and dried specimens in trade, and compile life-history characteristics, species distribution and demographic data; and (3) improve the collection of data quantifying the extent of harvest and international trade, documenting location and catch data by species, as well as data that will provide the best information about the current status of these species, the impact trade has on sea cucumber populations and their environments, and possible management approaches to promote sustainable harvest. We feel that this is an issue appropriate for discussion at COP 12, followed by referral to the Animals Committee for further action. Such a referral could come in the form of a Decision adopted at COP 12.

<u>Background Information</u>

A. Taxonomy

Sea cucumbers are echinoderms in the Class Holothuroidea (holothurians), which includes approximately 1250 species and six orders (Hendler et al., 1995). Of about 300 species found in shallow water tropical and subtropical environments there are over 25 species that are currently harvested, and also at least another four species harvested in temperate regions (Table 1). These are in the orders Dendrochirotida (550 species in 7 families, but only one genus in the family Cucumariidae, *Cucumaria*, is exploited) and Aspidochirotida (340 species in 3 families, with two families, Stichopodidae and Holothuuriidae, and eight genera, *Actinopyga*, *Bohadschia*, *Microthele* and *Holothuria*, *Isostichopus, Parastichopus*, *Stichopus* and *Thelenota* in international trade).

B. Biological Parameters

1. Life history

The average life-span of a sea cucumber is 5-10 years and most species first reproduce at 2-6 years of age. In general, temperate species must reach a greater age to achieve reproductive maturity than closely related tropical species. For instance, *Stichopus japonicus* grows in length from 4-20 mm per month, reaching its maximum size of about 25 cm within one year; this species matures after three years and has a life-span of 5 years. About 30 species are known to brood larvae (including species in the genus *Cucumaria*), with the incidence of brooding species increasing in temperate and boreal latitudes. Although a few holothurians are hermaphroditic, most are dioecious broadcast spawners that release eggs and sperm into the water column for external fertilization. Fertilized eggs develop into pelagic larvae that may spend 50-90 days in the plankton, being widely dispersed by water currents. In addition to a presumed high mortality of pelagic sea cucumber larvae, other factors impact reproductive success, including low mobility and small home range. As in other semi-sessile invertebrates, holothurians that broadcast gametes into the water column must be at a certain density to ensure fertilization success. Some temperate species are known to aggregate during spawning periods, but this is not reported from commercially important tropical species.

A number of species are reported to reproduce asexually by fission, with up to 20% of certain populations exhibiting fission. This phenomenon may increase in response to anthropogenic or ecological disturbances (Conand, 1996).

2. Distribution, behavior and ecology

Sea cucumbers are widely distributed in marine environments throughout the world, from intertidal zones to the deep-sea, with the highest diversity in the Indian and western Pacific Oceans. Holothurians are slow moving animals that live on the bottom in sand, mud, rock and reef environments and are often found among seaweed, seagrasses and corals. Some live buried in the sand and only expose their tentacles. Most commercially important species live exposed on rocks, cobble, sand or mud, or they emerge nocturnally.

Cucumber fisheries are primarily based on shallow water (up to 50 m depth) deposit-feeding species that inhabit soft-bottom environments including mangroves, reefs, lagoons and sand flats. One plankton feeder, *Cucumaria*, is also targeted in a temperate water fishery (Table 1). Although many species of sea cucumbers have a wide distribution, occurring throughout entire ocean basins, most species have very specific habitat preferences, including a specific zone within reef habitats, algae, or grassbeds.

Adult sea cucumbers have few predators that ingest entire animals. Francour (1998) reports that several sea stars (19 species), fishes (26 species) and crustaceans (17 species) ingest large quantities of holothurians, although sea cucumbers have evolved effective defenses against most animals, including the release of toxic chemicals and unique escape behaviors. Sea cucumbers have the ability to eviscerate parts of or its entire internal organs to ward off prey, and these regenerate rapidly.

3. Importance in the ecosystem

Sea cucumbers are important components of the food chain in temperate and coral reef ecosystems at various trophic levels, and they play an important role as deposit feeders and suspension feeders. Sea cucumbers have often been called the earthworms of the sea, because they are responsible for the extensive shifting and mixing of the substrate, and recycling of detrital matter. Sea cucumbers consume and grind sediment and organic material into finer particles, turning over the top layers of sediment in lagoons, reefs and other habitats and allowing the penetration of oxygen. Sea cucumbers are important in determining habitat structure for other species, and can represent a substantial portion of the ecosystem biomass. In absence of fishing pressure, sea cucumbers may occur on Indo-Pacific reef flats at densities in excess of 35 per square meter, where individuals process an immense amount of sediment each day. For example, the common western Atlantic *I. badionotus*, which is about 20 cm in length, can process 160 g of ocean debris in 24 hours (Fechter, 1972). In Bermuda, in an area of 4.4 km^2, *I. badionotus* populations have been estimated to ingest 500-1000 tons of sand annually. This process prevents the build-up of decaying organic matter and may help control populations of pest and pathogenic organisms including certain bacteria and cyanobacterial mats. In some areas, extirpation of sea cucumbers has resulted a hardening of the sea floor, eliminating habitat for other benthic and infaunal organisms.

Rapid declines in populations may also have serious consequences for the survival of other species that are part of the same complex food web, as the eggs, larvae and juveniles constitute an important food source for other marine species including crustaceans, fish and molluscs. In addition, several species have unique symbionts, including molluscs and fish.

4. Population status and trends

Empirical data concerning the population density are available in only a very few cases, with the density determined by the nutritional value of the substrate, as well as the amount of fishing pressure. There are a growing number of reports indicating that sea cucumber populations are declining world-wide in tropical and subtropical countries with sea cucumber fisheries, with reports of overexploitation from collection areas in Australia, India, Thailand, Papa New Guinea, the Galapagos and other locations. In particular, the fishery for the two most valuable species (*H. nobilis* and *H. scabra*) has collapsed in a number of locations due to overfishing, and significant declines of these and other species have been noted in many south Pacific and SE Asian locations.

Populations may fail to recover once their density is reduced below a critical mass, even after fishery closures, and some studies indicate that populations of sea cucumbers in overexploited fishing grounds may require as much as 50 years in the absence of fishing pressure to rebuild. For instance, the Torres Strait fishery for *H. scabra* was closed in the mid-1990s, and the current biomass today is still estimated at less than 8% of the virgin biomass (Skewes et al., 2000). Average densities of *H. nobilis* populations for the Torres Straits, Papua New Guinea (PNG), New Caledonia and Tonga ranged from 9.4-18.4 individuals per hectare in the late 1980s, with maximum reported densities of 275 ind./ha (Preston, 1993). In PNG waters, peak catches occurred in 1991-1992 and subsequently declined, with the fishery switching to other less valuable species. As sites were serially depleted, fishing effort shifted to more distant locations, until the fishery was closed. Surveys conducted in 1995-1998 on Warrior Reef identified progressively smaller breeding populations each year, leading to smaller and smaller recruitments. Breeding year classes (larger than 18 cm) were heavily depleted in both Australian and PNG waters, while recruiting year classes were more abundant in Australian waters. Surveys conducted in PNG several years after closure indicate little recovery; both adults and the recruiting year class were notably absent (D'Silva, 2001).

On the Great Barrier Reef in Australia, densities of *H. nobilis* were found to be four to five times higher on reefs protected from fishing when compared to 16 reefs open to fishing. In addition, the average weight of individuals was substantially smaller (1763 g) on fished reefs than on unfished reefs (2200 g) (Uthicke and Benzie, 2001). In addition, the fishery for *H. nobilis* and *H. scabra* has recently collapsed along the tropical east coast of Australia due to overfishing.

From July 1996 to December 1998, surveys were conducted in 148 sites in the Peninsular Malaysia and Sabah. Species abundance was relatively high for most species, but holothurians were patchily distributed, and one species in particular, *S. horrens*, was rare in sites of traditional fisheries (Forbes, 1999).

In Baja, Mexico, *H. impatiens* surveys were conducted between 1990-1996. Densities in 1990 were 1.46 animals per m^2 with a decline to 0.09 per m^2 by 1992. No signs of population recovery were evident in subsequent years (Castro, 1997).

With the exception of *S. japonicus*, which has been targeted for 100s of years in Japan, most temperate populations appear to be stable at this time. However, this stability may be because harvest pressure is substantially less and the fisheries are relatively recent. In Alaska, *P. californicus* occurs in sand, shell debris, cobble and rock areas to depths of 183 m, and is most common at 10-20 m and 110-120 m depth, occurring at densities of only 0.03-0.3 animals per m^2 (Woodby et al., 2000). In California, surveys have been conducted in the Channel Islands and Santa Barbara Channel since 1982. These show that Channel populations of *P. parvimensis* are highly variable among sites, but have been declining in fished sites since 1990. Also, population densities in two no-take areas were 50-80% higher than in fished areas (California Department of Fish and Game, 2001). In British Columbia, *P. californicus* densities are estimated to range from 5.5-18 animals per meter of shoreline, based on transects conducted from 1998-2001 (Fisheries and Oceans, Canada, 2002). Some temperate sea cucumbers that are the target of commercial fisheries may occur at much greater densities in specific environments, when compared to closely related tropical species. For instance, *C. frondosa* is found in waters less than 30 m depth, where it may account for more than 50% of the benthic biomass (Chenoweth and McGowan, 2001).

C. Threats

Sea cucumbers are threatened by overexploitation to supply international markets with luxury food items, as well as a source of aquaria organisms and specimens for biomedical research. The high value of some species, the ease with which such shallow water forms can be harvested, and their vulnerable nature due to their biology and population dynamics all contribute to the overexploitation and collapse of fisheries that have been reported in some regions. Sea cucumbers are sedentary animals that are especially susceptible to overexploitation because they are large, easily collected, and do not require sophisticated fishing techniques. Heavy fishing pressure can cause a decline in the density and biomass of the target species, and populations may be unable to rebound once they fall below a critical biomass. Many holothurians are broadcast spawners, and fertilization success is highly dependent on population density. Certain cold waters species may aggregate during breeding periods, but movement is limited as holothurians generally have a limited home range. Reduction of population densities by fishing may render remaining individuals incapable of successful reproduction, due to the greater distance between males and females.

Holuthurian fisheries have existed for at least 1000 years for traditional and subsistence use, but the amount of harvest and the number of fishers began to increase in the late 1980s in SE Asia and the south Pacific to supply a growing international demand. In response to increased demand in Asian markets, the tonnage of holothurians in international trade increased threefold from 1985-1986, and it again doubled during 1987-1989, with an estimated worldwide trade of 9,000 mt (dried); exports continued to increase in the early to mid 1990s and reached about 13,000 mt by 1995 (Conand 1997; 1999). Despite limited management controls in some areas, holothurian abundance fluctuates greatly. There are numerous reported cases of fisheries going through boom and bust cycles, and high value species are typically rapidly depleted shortly after a fishery became established. Certain species such as *H. scabra* are presently over-exploited in many countries and the focus is shifting to other lower-value species and to new locations, including the eastern Pacific, North America and the Caribbean. The trend in this fishery is for collectors to remove all animals from one location, then search for new populations in other areas. Until recently, deepwater populations may have provided a refuge for some heavily fished species, because most collection was done by wading or snorkeling. However, populations have been depleted in shallow water in many locations, and the use of SCUBA and hookah is rapidly increasing throughout the Pacific and SE ASIA. Populations have been exploited so heavily in some Pacific Islands that it is predicted to take 50 years for the stocks to recover.

A second threat contributing to their decline is habitat degradation and loss. The Global Coral Reef Monitoring Network reported that an estimated 11% of the world's coral reefs were lost by 1992 and another 16% are no longer fully functional (GCRMN, 2000). In addition, Reefs at Risk (1998) reported that 58% of the world's reefs are potentially threatened by human activities, with the greatest impacts associated with overfishing and destructive fishing, coastal pollution and sedimentation, and habitat alteration. Southeast Asia contains 34% of the world's reefs, of which an estimated 88% of all reefs are threatened by human activities, including 64% that are threatened by overfishing (Burke et al., 2002). Mangroves and grassbeds are being destroyed by many of the same activities that threaten coral reefs.

D. Utilization and Trade

1. National Utilization

Sea cucumbers have been harvested commercially for at least 1000 years for traditional uses in certain parts of southeast Asia and the South Pacific, but the level of harvest has generally been very low. Today, sea cucumbers form a large, valuable export fishery throughout most South Pacific and Asian countries, and the fishery has recently expanded to New Zealand, Africa, South America and North America. The gutted body wall of sea cucumbers are eaten raw, boiled or pickled and specialized products are produced from the gonad, respiratory trees and viscera. The most important product is the dried body wall, which is exported as bêche-de-mer; bêche-de-mer is also called trepang or hai-som throughout the tropical Indo-Pacific. In addition, the muscle bands in some species are used as clam substitutes in Asia and the U.S. Processing methods for bêche-de-mer include boiling, gutting, smoke-drying and sun drying, which considerably reduces the length and weight of the final product (Conand and Byrne, 1993). In Samoa, Tonga, Cook Islands, Palau, Pohnpei and other countries a local fishery exists for *S. variegatus* and other species. These fisheries are likely to be sustainable, as only the intestines are collected for local consumption, and the animals are thrown back into the sea where they regenerate their organs.

In the mid- to late-1990s, additional markets for sea cucumbers emerged for biomedical research and for use in home aquaria. Bioprospectors have become interested in sea cucumbers for natural-products research and development. Holothurians contain chondroiton and glucosamine, which are important building blocks of cartilage, as well as other bioactive substances that have anti-inflammatory properties and anti-tumor activity (Mindell, 1998). Several commercial products produced from sea cucumber extracts have been marketed in recent years, including ArthiSea and SeaCuMax (arthritis medicine), nutritional supplements, and Sea Jerky (for joint problems in dogs).

Tropical and subtropical sea cucumber fisheries are multi-species with fishers primarily targeting shallow water (up to 50 m depth) deposit-feeding species belonging to two families and eight genera: *Actinopyga*, *Bohadschia*, *Microthele* and *Holothuria* (Holothuridae) and *Isostichopus, Parastichopus*, *Stichopus* and *Thelenota* (Stichopodidae). Fishing gear and methods include small bottom trawl nets (roller pulling nets and beam trawl nets) for sandy bottoms, spears, hooks and scoop nets for reefs, and diving gear for deeper reef and lagoonal environments. Holothurians that are targeted by bêche-de-mer fisheries range in size from about 5 cm to over 1 m in length. The species of highest commercial value in tropical waters of the western Pacific and Indian Oceans are *H. fuscogilva* (white teatfish), *H. nobilis* (black teatfish) and *H. scabra* (sandfish). Species of medium value include *A. echinites* (brownfish), *A. miliaris* (blackfish) and *T. ananas* (prickly redfish). Species of low value include *H. atra*, *H. fuscopunctata*, *S. chloronotus* and *S. variegatas*. A small, but growing fishery exists in the eastern Pacific, including Ecuador and Galapagos for *I. fuscus.* Between 1983-1990 there was a dramatic increase in the demand for bêche-de-mer, coupled with a decline in total landings (Preston, 1993). Most tropical fisheries are based on multiple species, although Indian Ocean fisheries have been traditionally based on one species, *H. scabra* (Table 2).

Unlike tropical holothurian fisheries, most temperate fisheries are based on single species. Temperate fisheries are divided into western Pacific regions (*S. japonicus*), Eastern Pacific coasts of North America (*P. californicus* and *P. parvimensis*), and a small fishery in the Atlantic for *Cucumaria frondosa*. Sea cucumbers are commercially harvested in the United States, including Alaska, Oregon, California, Washington, and Maine (Table 5). A fishery for *P. californicus* has existed in Washington since 1970. Catch until 1987 was less than 185 metric tons (mt) per year, and between 1988-1991 ranged from 871-1243 mt. In California, *P. californicus* and *P. parvimensis* are harvested by divers using a hookah and trawl gear. For the first 8 years, the fishery was focused primarily around Santa Catalina Island using divers, with annual landings of about 24 mt. In 1982, the fishery shifted to the Santa Barbara Channel and catch increased to 63.5 mt, 80% of which represents trawl landing. In 1996 combined dive and trawl landings reached a maximum of 380.8 mt. Landings between 1997-1999 declined, with more than 80% involving divers and a substantial decline in trawl fishers, primarily due to permit violations. A small fishery emerged in Oregon in 1993. Landings doubled from 2.34 mt in 1993 to 4.78 mt in 1994. A fishery for *P. californicus* also began in Alaska in 1990. The total harvest for the Kodiak District Sections is 56.7 mt, or roughly half the historic harvest between 1993-1996 (Ruccio and Jackson, 2000). In Maine, a fishery for *C. frondosa* emerged in 1994, with about 1360 mt harvested in the first year. Fishing effort focused in nearshore rocky-bottom habitats using scallop-drag gear (Chenoweth and McGowan, 2001). In Canada, harvest primarily occurs in British Columbia (B.C.) by divers off the east, west, and central coasts of Vancouver Island and Prince Rupert, in an area amounting to about 25% of the total coastline of B.C. Canada. There is also a new experimental fishery for *C. frondosa* in Quebec.

World landings of sea cucumbers were estimated to amount to 25,000 mt (live) in 1983. *S. japonicus* was the most important species by weight during the early 1980s, with over 13,371 mt harvested in Japan and Korea each year prior to 1985. Most of the remaining harvest consisted of tropical species from the Indo-Pacific. Worldwide harvest increased threefold from 1985-1986, and it again doubled during 1987-1989 in response to increased demand in Asian markets. In 1989, a worldwide catch of 90,000 mt was recorded, consisting of about 78,000 mt from the South Pacific and SE Asia, and 12,000 mt from temperate fisheries. Holothurian fisheries have continued to expand, with a total worldwide harvest of 120,000 metric tons by the early 1990s (Conand, 1997).

2. Legal international trade

The world bêche-de-mer market is controlled largely by Chinese traders. The Chinese have sought sea cucumbers for over 1000 years in India, Indonesia and the Philippines, but traders began gathering them from a wider area in the 18th and 19th century (Conand and Byrne, 1993). An increased demand for sea cucumbers in Asian markets worldwide has led to a dramatic increase in international trade beginning in the late 1980s. Between 1992-1994, dried sea cucumber imports reached a global annual volume of over 12,000 mt (120,000 mt live), valued at about US $ 60 million. The trade continues to increase, with a total world production of 13,062 dried bêche-de-mer reported from international markets in 1995 (Jaquemet and Conand, 1999). Sea cucumbers are worth from $4-$70 per kg dried, depending on the species and size.

There is a substantial amount of information on the trade routes and main sea cucumber markets, but the volume and location of harvest and export are still incompletely recorded. Much of the bêche-de-mer in international trade is exported from the producer countries to a central location, and then it is re-exported to Chinese consumers (Conand and Byrne, 1993). Hong Kong SAR, Singapore and Chinese Taipei are the main international bêche-de-mer markets. However, trade routes are many, varied and often erratic, and individual countries may export, import, and re-export sea cucumbers. For instance, Malaysia has a well- established holothurian fishery, and they also import and export holothurians. Trade statistics are further complicated by the variety of products available in international markets, including several types of dried holothurians (spiked & not spiked), as well as frozen, live, fresh or chilled, and salted or in brine (Table 6).

Hong Kong SAR, China, Singapore, Malaysia, Chinese Taipei, Korea and Japan currently account for almost 90% of the total imports of bêche-de-mer, with approximately 80% of the overall international trade destined initially for Hong Kong SAR (Table 3). Hong Kong SAR imported over 9000 mt in 1988 and close to 6000 mt in 1989 (average value $27 million) and re-exported about 3,500 mt. Trade data provided by the Hong Kong SAR Customs and Statistics Department indicate that the main suppliers are Indonesia and the Philippines, and most re-exports are to China (80%), followed by Singapore and Chinese Taipei. Singapore currently receives about 50% of its imports from Hong Kong SAR, with PNG, Tanzania and Madagascar the other main suppliers. An examination of trade statistics for the three main markets also reveals the existence of two-way trade, particularly for the Singapore and Chinese Taipei markets. For instance, between 1995-1996 Singapore shipped 72% of its re-exports to Hong Kong SAR and 6% to Chinese Taipei; Chinese Taipei also imported 42% of its bêche-de-mer from Hong Kong SAR, with imports destined for local consumption or later re-exportation, depending on the market (Jaquemet and Conand, 1999).

Based on import data from Hong Kong SAR, the number of exporting countries for dried, fresh and frozen bêche-de-mer has continued to increase from about 25 countries in 1989 to 49 in 2000/2001, with exports dominated by about 30 species. In 2000 and 2001, Chinese Taipei imported sea cucumbers from 28 countries. Export data are available for only a small number of countries, however (Table 4). In the late 1980s and early 1990s, Indonesia was the major world producer and exporter, with a production of around 4,700 mt of dried sea cucumbers per year since 1987. The Philippines emerged in the mid-1990s as the second major producer and exporter of dried sea cucumbers, with catches of around 20,000 mt (live) per year (Conand and Byrne, 1993).

3. Illegal trade

There are reports that PNG fishers poach sea cucumbers in Australian waters of Torres Strait near Warrior Reef. Illegal fishing was first reported in 1991, including both day and night poaching, and it continued through closure of the fishery in 1993. Australian authorities increased patrols and apprehended 163 fishers during 1992, but most were not prosecuted.

Exploitation of sea cucumbers started in 1990 in the Galapagos, and was prohibited in 1992, but illegal fishing continued. A two-month experimental fishery was established in 1994 with a limit of 550,000 sea cucumbers, and was closed one month later due to fishing violations. Uncontrolled and extensive fishing, far exceeding the limits originally established, is largely driven by the high value of this species in foreign markets. The Galapagos fishery remained closed until 1999, but illegal fishing continued. The fishery was re-opened for 2 months in 1999 under a new management plan that prescribes an annual two-month fishing season, a fixed quota, and a zoning plan with no-take areas. 4,401,657 cucumbers were legally exported (112 mt, dried) in 1999.

Reports indicate that the west coast of the U.S. is a source of sea cucumbers for foreign markets and a trans-shipment point for sea cucumbers originating in Latin America en route to Asia. The United States attempted to use the Lacey Act to control trans-shipment of illegal Galapagos sea cucumbers through the United States, but no shipments were seized. Efforts to control such illegal trade were hindered by difficulty in verifying the origin of the sea cucumbers shipments containing specimens from many different countries of origin (Jenkins and Mulliken, 1999).

Another major problem with sea cucumber fisheries has been poaching by foreign vessels. In a northeastern Venezuelan park, 930 kg of illegal catch was confiscated from Asian fishers during 1991-1992. The trawl fishery for *P. parvimensis* and *P. californicus* in California increased dramatically in the mid 1990s. However, 16 fishers were excluded from the fishery in 1997 due to fraudulent permits obtained by foreign vessels. In the Seychelles, Indian Ocean, the first documented case of illegal bêche-de-mer fishing occurred in April 2001, involving a Malagasy fishing boat. Several metric tons of sea cucumbers were confiscated.

E. Conservation and Management

1. Captive breeding, husbandry and stock enhancement

Three approaches to enhance and increase yield of sea cucumber stocks include relocation of recruits, induced asexual reproduction through fission, hatchery rearing of larvae, and grow-out of juveniles in cages placed on the sea floor. Researchers have had success inducing spawning in sea cucumbers with high gamete fertilization rates. Larvae can be raised fairly easily on various types of algae, however, there are some problems with microbes and pathogens. Relocation of recruits and juveniles from areas of high abundance to areas of low abundance as a form of sea ranching has been recommended (Joseph, 1992). Aquaculture and restocking studies have greatly expanded over the last two to three years, with programs underway in Vietnam, Marshall Islands, Japan, Maldives, New Zealand, and India. Thus far, *H. scabra* is the only tropical holothurian that can be mass-produced in hatcheries, however, China reports that they have been producing about 1000 mt of *S. japonicus* each year, and 1025 mt of several other species in another location during 2001.

International Center for Living Aquatic Resources Management (ICLARM) is examining the potential for releasing cultured juveniles of *H. scabra* and *A. mauritiana* as a means of restoring and enhancing tropical sea cucumber stocks (Battaglene, 1999). ICLARM has produced over 200,000 juveniles from six spawning events in the mid-1990s. In 2000, they released 2600 juveniles in the Western Province , but survival rates are unknown. Japan has made progress in hatchery production of *S. japonicus*, with an annual production of 500,000-1,000,000 juveniles per year since 1993. In 1995 11 farming centers released 2,557,000 9 mm sea cucumbers but it is not known if these survive.

Cage culturing of wild-caught juvenile *H. scabra* has been reported from Sulawesi, and hatchery production in Bali, but researchers report a problem with fungal infections in 10-20 mm juveniles. A sea cucumber ranching operation was established on an atoll in the Maldives involving *H. scabra* from India, a species that is not native to this area. In less than one year, juveniles have grown to 15 cm and are being harvested for export.

Several high-value species have been reported to reproduce asexually by fission; induced fission has been examined as a potential technique to propagate commercially important species (Reichenbach et al., 1997).

2. Legal protection status

There are currently no legal international mechanisms to protect sea cucumbers. However, some countries have implemented bans on the harvest of certain species or in certain locations in response to localized extirpations. Protective measures for holothurians are summarized by country in Table 2.

3. Fishery management provisions

There is currently insufficient knowledge to develop models for rational management of bêche-de-mer fisheries due to very limited biological information of the local fisheries and stocks (Conand, 1990). While sea cucumber fisheries remain unregulated in a number of developing countries, other countries have established management measures to various degrees, in attempt to prevent overfishing (Table 2). Typically, this includes specific collection and no-collection areas, permitting systems, quotas, seasonal harvest, rotational harvest, and other strategies. In many countries, certain sites have been closed to harvest a short time after the fishery commenced, due to rapid overexploitation and biological or commercial extirpations. In some locations, the take of certain species is now prohibited due to their rarity.

Traditional fishery management approaches were formerly successful in many countries because holothurians were primarily harvested for traditional and subsistence uses. In many countries, these approaches are no longer effective because 1) some of the traditional cultures are being lost; 2) population growth has put increasing pressure on the resource; 3) populations of sea cucumbers are being targeted that were not traditionally exploited, due to availability of motorized boats and SCUBA and hookah gear which allows fishers to reach distant and deepwater reefs and lagoons; and 4) non-local collectors are fishing in many areas and poaching and illegal trade has increased.

a. Australia. Since 1986 there has been a quota on the numbers of license holders, with around 18 fishers involved in the fishery in any given year. A total allowable catch of 500 metric tons (all species) was implemented in 1994. Decreasing catch rates of *H. nobilis* on the Great Barrier Reef prompted management agencies to close the fishery in October 1999 (Uthicke and Benzie, 2001). The fishery for other species is still open, and there is now strong fishing pressure on *H. fuscogilva*. In the Torres Strait, a size limit of 15 cm, total allowable catch of 90% of the estimated yield, a ban on underwater breathing gear, a licensing system and logbooks, and spatial and temporal closures have been used to regulate the fishery.

b. Mexico. A fishery for three species has existed in Baja since 1988, with annual catch fluctuating between 450-1038 mt (live weight) for each coast until 1995 and a dramatic drop in 1996 (40 and 160 mt for the east and west coast respectively) (Castro, 1997).

c. United States. There are small commercial and recreational fisheries for sea cucumbers in many coastal waters of the United States. Fishery management plans have been established in state waters of Maine, Washington, California, Alaska and Florida, and in federal waters of the U.S. Caribbean and South Atlantic. In Alaska several management measures were implemented in 13 areas in the Westward region to ensure viability of *P. californicus* stocks. These measures include: 1) dive gear is the only legal gear type; 2) divers obtain permits and submit logs; 3) seasonal closure to protect spawning aggregations; and 4) guideline harvest levels. Since 1994, the Alaska Department of Fish and Game has monitored fishery performance, relative abundance and population strength using dockside interviews and fishery logbook data. This has resulted in reductions (in the case of poor performance) or increases (areas with stable or increasing CPUE) in the annual quota. In addition, field surveys indicate that the fishery is sustainable. In some sites the biomass has declined but population abundance has remained stable or increased, suggesting recruitment events. In California, a special permit was required for sea cucumber harvest beginning in 1992-1993, with separate permits for each gear type and a limit on the total number of permits implemented in 1997. There are currently 113 sea cucumber dive permits and 36 sea cucumber trawl permitees. Recreational harvest is prohibited in nearshore areas less than 6 m depth. A fishery for *P. californicus* has existed in Washington since 1970. Until 1987 the fishery was monitored through logbooks. Resources began declining in the late 1980s and new management strategies were implemented including rotation among four harvest areas, with a 6-month allowable harvest followed by a 3.5 year closure. Washington has established a daily limit of 25 animals for two species (*P. californicus* and *P. parvimensis*) for the recreational fishery as well. In Oregon, fishers must obtain a commercial shellfish harvest permit.

d. Canada. Commercial exploitation began in 1971, with a rapid escalation during the 1980s, which led to conservation concerns and implementation of management actions. The commercial fishery is a limited entry dive fishery with collection restricted to 25% of the coastline, with 25% for research and 50% closed to harvest. The annual fishery lasts only for about three weeks when muscle weight is greatest and animals have no internal organs. In 1995 a quota was established of of 233 m tons divided among 84 licenses; total harvest for 2001 is 385.6 tons. A new fishery for *C. frondosa* emerged in Quebec in 1999, with one experimental license. Three licenses were issued in 2000 and 5 licenses in 2001.

e. Torres Strait. The Torres Strait fishery was reestablished in 1994. Regulations within the Australian section of Torres Strait implemented in the fishery include: limiting the method of collection to either hand or hand-held non-mechanical implements; a ban on the use of SCUBA or hookah gear; maximum size of Islander dinghies to less than 7 m length; total allowable catch and minimum size limits.

4. Trade controls

There are currently no restrictions on international trade in sea cucumbers, except for those species protected at a National level.

5. Management Options

There is substantial risk associated with managing fisheries of species assemblages (e.g., “sea cucumbers” vs. managing and collecting catch data for individual species). As one species is depleted, fishing effort may shift to less valuable species, however, the CPUE for the “sea cucumber” fishery may actually increase. There is also the danger that fisheries targeting more abundant species can support continued fishing pressure on rare, but extremely valuable, species. Thus, the management presumption that a fishery will become economically extinct before it is biologically extinct is not necessarily true.

The protection of whole reefs from fishing appears to be an effective management tool for the conservation of holothurian stocks. However, the division of a reef into fished and unfished zones has been found to be affective only when the protected areas are large (Uthicke and Benzie, 2001).

Issues that need to be addressed in relation to CITES

To address the fundamental questions of whether CITES listing is appropriate for and can contribute to the conservation of sea cucumbers a number of issues have to be considered, including taxonomic uncertainties within the families, ability to distinguish taxa in the form they are traded, adequacy of biological information for making non-detriment findings, and ability to make legal acquisition findings, among others. Below we elaborate on what we perceive to be some of the key issues.

A. Taxonomic uncertainties within the families

While the taxonomy of the holothurian families is generally well known, the distinction of similar species is difficult, as they may exhibit similar morphology. The most important features used to distinguish families of sea cucumbers is a calcareous ring that encircles the pharynx. In recent years several new species have been described from the Indo-Pacific, which is the center of holothurian biodiversity. Nevertheless, there are many undescribed large species that are common in shallow water and there are relatively few holothurian taxonomists. The large number of extant sea cucumber species (1250) complicates this issue even further.

B. Ability to distinguish taxa in the form they are traded

It is possible to identify most of the common species that are traded as live animals for home aquaria and other uses, based on the gross morphology. In contrast, it is very difficult to determine the species from the dried processed product, which is the dominant component of the international trade in sea cucumbers. Customs officials and wildlife inspectors may have difficulty identifying dried specimens even to genus. Photos of dried specimens of the main commercial species of the western tropical Pacific are available in a booklet from CPS (Conand, 1998), but there are no detailed identification guides (as in the case of seahorses, for example). Most individual sea cucumber species can be identified by holothurian taxonomists by using the calcareous skeletal ossicles found in the body wall, and the ossicles are preserved during the drying process.

C. Adequacy of biological information for making non-detriment findings

There are very limited data currently available on the biological status of populations from areas with holothurian fisheries, with exception of selected countries such as Australia, Canada, New Zealand and the United States that have established, regulated fisheries. In these countries, population surveys are undertaken and this information is used in combination with fishery–dependent data to determine sustainable levels of harvest. Unfortunately, various parameters such as recruitment, growth and mortality are available for only selected high value species, and catch data may be incompletely reported, complicating the ability of Scientific Authorities to make a non-detriment finding. In addition, in response to the rapid expansion of holothurian fisheries and the high value of beche-de-mer, several countries have established experimental fisheries without having sufficient information to determine sustainable harvest. There are virtually no data available on the biological status of sea cucumbers and few management measures in the two largest exporting countries, the Philippines and Indonesia, and thus it is unlikely that these countries could make a non-detriment finding without capacity building for improved monitoring and data collection.

D. Ability to make legal acquisition findings

Because of the complex trade routes for sea cucumbers, often involving import and subsequent re-export, or transshipment ports that export mixed shipments of different origins, it is often very difficult to determine the country of origin. It is also difficult to determine whether the harvest was legal, as shipments often include multiple species that are difficult to differentiate when dried, and those countries that have established regulations for holothurian fisheries generally prohibit the harvest of selected species or in specific locations, while harvest of other species is legal. Furthermore, the processed product generally passes from the producing country to the main world distribution centers (Hong Kong SAR, Singapore and Chinese Taipei) before being imported to the consumer country, making it difficult to determine the origin of the bech-de-mer.

E. Research needs

Further studies are needed on: recruitment, growth, and mortality of most commercial species; stock assessments; and improved statistics on catch and international trade (Table 7). Very little is known concerning recruitment, growth and mortality of most species. More research is needed to quantify population parameters, and stock assessments are needed in fished and unfished areas to develop sustainable management approaches. Because of the paucity of data for the spatial distribution of fishing effort, the depletion of stocks may not be detected using surplus yield models without detailed field monitoring. Additionally, fishery monitoring that only involves catch and effort statistics is likely to be erroneous as fishers may report catch as being made in other areas than those actually fished. For instance, the overall catch for the *P. californicus* fishery in Washington State, USA, appeared to be stable, but in reality half of the fished areas were overfished. As stocks were serially depleted CPUE did not appear to decrease, due to a shift in fishing effort to deeper waters (Bradbury, 1994).

Population genetic analyses are necessary to determine the appropriate scale of management strategies. In Australia, *H. nobilis* populations were found to have high gene flow, suggesting that recruits can be received from a wide geographical area and stocks could be managed on a regional scale. In contrast, separate genetic stocks of *H. scabra* were detected, which implies limited recruitment within regions that may reduce the potential for recovery of overfished areas. *H. scabra*, in particular, needs to be managed as separate stocks and local refugia are needed (Uthicke and Benzie, 2001).

F. Capacity building

Capacity building is necessary in most developing countries with sea cucumber fisheries to promote development and implementation of sustainable management approaches and conservation of sea cucumber populations through mariculture, restocking programs, and other strategies (Table 7).

Annex A. Country reports from range state consultations

Australia: Sea cucumbers are collected in Queensland, Torres Strait, Northern Territory and Western Australia. Queensland east coast fishery harvest 11 major species, but 4 are currently of highest value - *H. nobilis, H. fuscogilva, B. marmorata subsp.,* and *T. ananas*. *S. chloronotus* (greenfish) may become more valuable with the recent discovery of pharmaceutical products. Approx 200 mt are harvested annually in Queensland as part of a quota managed fishery with a Total Allowable Catch (TAC) for the east coast of 380 mt allocated to 19 collectors. Management is hindered by illegal catches and unreliable catch return data. CPUE of black teatfish peaked in 1996 and steadily declined until 1999, when the fishery was closed to protect breeding stocks.

Bangladesh: Over harvest of sea cucumbers is reported.

Chagos: Illegal collection of holothurians is reported to be a problem.

China: They do not support CITES listing for sea cucumbers or other fishery species and state that there is insufficient trade data and information on the status of wild populations. In addition, they claim that "artificial bred" sea cucumbers have almost replaced wild harvest.

Commonwealth of the Northern Mariana Islands (CNMI): In 1995 and 1996 cucumbers were harvested from Rota; due to overexploitation the fishery moved to Saipan, but it was shut down shortly thereafter, because stocks were rapidly depleted.

Cuba: The CITES Management Authority provided statistics on the density of the four most common species of commercial interest and indicated that catch is currently very low.

East Africa: Sea cucumber populations crashed following the initiation of export fisheries.

Fiji: *H. fuscogliva*, *H. scabra* and *H. nobilis* are reported to be endangered or threatened as a result of overfishing.

Hong Kong SAR: Provided trade statistics for 2000 and 2001, broken down by exporting country. Data include separate tables on imports and re-exports. Based on these data, over 4758 metric tons of holothurians were imported in 2000 and over 4382 mt in 2001 and a large portion of this was re-exported (4,221 mt in 2000 and 3866 mt in 2001).

India: Andaman Islands has a sea cucumber fishery.

Madagascar: Fishers report that they are diving to deeper depths and are looking for new fishing grounds because historical fishing grounds are depleted. Fishers are targeting juveniles and cause damage to the environment by overturning and breaking coral heads to collect sea cucumbers.

Mauritius: No harvested species of sea cucumbers have been identified, but sea cucumber abundances are generally too low to support commercial exploitation.

Norway: The Directorate for Nature Management responded that there are no directed commercial fisheries for sea cucumbers in Norway. Bycatch of *Stichopus tremulus* is commonly reported, but specimens are not retained for sale and are believed to survive the discard process.

Federated States of (FS) Micronesia: A small sea cucumber fishery operating in Yap was closed in the mid-1990s.

Papau New Guinea (PNG): Sea cucumbers are the largest component of the invertebrate export catch with over 680 mt exported in 1998.

Singapore: Two species of sea cucumbers occur locally: *H. scabra* and *Phyllophorus parvipedes.* Both species are reported to be vulnerable to harvesting, but abundances are too low to support a commercial fishery.

Spain: They would consider a proposal to list particular species if there is biological and commercial information to justify inclusion in CITES appendices.

Chinese Taipei: Data were provided on imports and exports of sea cucumbers, broken down by the type of product (Table 7).

Tonga: Exports of sea cucumbers occurred during the early 1990s, but export has been banned for 10 years.

Wallis-Futuna: Exports sea cucumbers.

Yugoslavia: Four species of sea cucumbers occur in territorial waters. Three of these, *H. tubulosa*, *H. poli*, and *H. forskali* have become the target of a fishery in recent years, but export is unregulated. Yugoslavia supports listing these species on Appendix II.

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Table 1. Primary species involved in the international trade in sea cucumbers and location of collection. High value (*), medium value (**) and low value (***) species are indicated. Most species shrink to approximately 50% of their length and 8% of their weight when dried.

Species	Common name	Maximum Size (live)	Distribution
Actinopyga lecanora **	stone fish		S. Pacific
*A. echinites****	brownfish (deepwater red fish)		S. Pacific
*A. miliaris***	black fish		S. Pacific
*A. mauritiana***	surf red fish	up to 15 cm	S. Pacific
Athyonidium chilensis			Peru, Chile
*Bohadschia vitiensis****	brown sandfish		S. Pacific, Indian
*B. graeffei****			S. Pacific
*B. argus****	leopard (tiger) fish		S. Pacific
*B. marmorata mamorata***	chalky fish		
*B. marmorata vitiensis***	brown sandfish		
Cucumaria frondosa	pumpkins; orange footed cucumber	50 cm maximum	West Atlantic (Maine/Canada)
*Holothuria fuscopunctata****	elephant trunk fish		S. Pacific
*H. fuscogilva**	white teatfish		S. Pacific, SE Asia
H. impatiens		15-20 cm	Mexico, Veracruz
*H. nobilis***	black teatfish		S. Pacific, SE Asia
H. scabra *H. scabra versicolor**	sandfish		S. Pacific, SE Asia, Indian S. Pacific, SE Asia
*H. edulis****	pink fish		S. Pacific
H. mexicana	Donkey dung	30-50 cm	Venezuela
*Halodeima atra****	lolly fish	30 cm maximum	S. Pacific
Isostichopus badionatus		45 cm	Caribbean
I. fuscus *(Stichopus fuscus)*		21 cm average; 30 cm max	East Pacific from Baja to Peru (Galapagos)
Parastichopus parvimensis *(= Stichopus parvimensis)*	warty sea cucumber	reaches 45 cm	East pacific (California/Mexico) [to Cedros Island, Baja]
P. californicus (=Stichopus californicus)	giant red sea cucumber	30 cm average; maximum 50 cm	East Pacific (US/Canada)
S. mollis			New Zealand
*S. chloronotus**	green fish		S. Pacific
*S. variegatus**	curry fish	1 m length; 21 cm diameter	SE Asia, S. Pacific
S. japonicus			Japan

*Thelenota anax****	amberfish	S. Pacific
*T. ananas**	prickly redfish	S. Pacific

Table 2. Countries involved in the export of sea cucumbers. Species collected, type of use, status of fishery and existing regulations. Information was compiled from a variety of sources, with many reports identified in the SPC Beche-De-Mer Information Bulletin.

Country/ Region	Species	Comments and trade volume	Status and management
Australia	*H. scabra;H. nobilis;T. ananas*; and 3 other species	Decreasing catch rates and declines in abundance and biomass of *H. nobilis*	Fishery for *H. nobilis* closed in October 1999 on the GBR.
Canada	*S. californicus*;*S. parvimensis; and C. frondosa*	east coast: *Cucumari*a; west coast: *Stichopus*	Fishery began in 1971 in BC, and a rapid increase in the 1980s; management actions including a limited entry, reduced fishing times, area closures, and an area quotas were introduced in 1991. New fishery started in Quebec in 1999.
Cook Islands	*A. mauritiana*	Low population abundance; small export market	Export from 2 areas in the 1980s, Rarotonga and Palmerston; most today for subsistence only.
Ecuador	*I. fuscus*	Fishery started in 1989	Stocks depleted; fishery moved to Galapagos
Fiji	*H. scabra; and A. miliaris*	*H. scabra* rose to 700t in 1988; stocks depleted. export of *H. scabra* prohibited (1995) *A. miliaris* 95% of exports (1993)	Harvest restricted to Fijian natives; use of scuba gear forbidden; minimum legal dry length of 7.62 cm for all species.
Galapagos (Ecuador)	*I. fuscus*	Fishery started in 1990	New management plan in place in 1999; two month season
India	*H. scabra; H. spinifera; B. marmorata; A. echinites; A. miliaris H. nobilis; T. ananas; H. atra; A. mauritiana; and S. chloronotus*	*H. scabra; H. spinifera; B. marmorata* collected over last 1000 years; began collecting other species in 1990, in response to high export value and population declines; *A echinites* and *A. miliaris* populations over-exploited in some areas after 2 years.	Sea cucumber collection banned in Andaman and Nicobar Islands; fishery exists in Gulf of Manner, Pal Bay, but CPUE and size of specimens has dramatically declined.
Indonesia	ten species	16 species harvested in Sulawesi. Estimated exports from Indonesia increased from 878 mt in 1981 to over 4600 mt? per year from 1987-1990.	The worlds largest source of sea cucumbers. No known management measures specific for sea cucumbers.
Japan	*S. japonicus*	The catch of *S. japonicus* in Japan has decreased annually by 5-10%, dropping from over 10,000 mt (wet weight) in 1978 to 7133 mt in 1987.	
Madagascar	*B. vitiensis; H. scabra*; and other species	Export fishery began in 1921, with exports of 50-140 mt annually. Exports increased from 56 mt in 1986 to over 500t in 1991 and 1994.	Declining exports, quality and size of sea cucumbers indicate resources are over exploited (1998).
Malaysia	*S. variegatus*	Imports may exceed exports. Annual catch between 1989-1991 is about 800 mt	There are no countrywide regulations for the holothurian fishery.
Maldives	*T. ananas;*	Export increased from 3 mt at the	

	H. nobilis; and B.marmorata	start of the fishery in 1986 to 740 mt in 1990.	
Mexico	*I. fuscus*	Fishery in Baja started an *I. fuscus* fishery in 1988, *P. parvimensis* in 1989 and *H. impatiens* in 1994. Catch for each species has ranged from 57-1038 mt (live).	*I. fuscus* declared endangered in 1994. Dive surveys in Baja indicate drops in CPUE from 2000 kg/diver/boat to 150 kg, along with increases in number of permits, diver hours and diver depths.
Micronesia		Minimal subsistence use.	No international trade (1993).
Mozambique	*H. scabra; H. nobilis H. fuscogilva*; *H. atra A. echinites; and A. mauritiana*	High fluctuation in exports may be due to irregular reporting or to over-exploitation.	In Inhambane Province, holothurian fishery is closed until stocks rebuild.
New Caledonia	*A. miliaris; H. scabra*; and *H. scabra versicolor*	Exports of over 125,000 kg in 1990 and 1991 with declines to less than 81,000 from 1992-1994.	*A. miliaris* harvest ~75% of exports. *H. scabra* harvest ~25% of exports.
New Zealand	*S. mollis*	Experimental fishery started in 1990.	15 t quota
Palau	*B. argus; and H. scabra*	Small export fishery (2.13 t 1990)	
Philippines	25 species including: *H. scabra; H. nobilis; B. marmorata; H. fuscogilva*; *H. atra;*and *A. Lecanora*	Exports increased from 250 mt in 1977 and 1189 mt in 1984 to 2123 mt in 1996.	
Papau New Guinea (PNG)	*H. scabra A. mauritiana H. nobilis H. fuscogilva* 13 other species	Dramatic increase in exports from 1982-1989.	In Torres Strait, 1000t of *H. scabra* in 1995; populations collapsed and fishery for this species stopped. In Milne Bay a total allowable catch of 140 mt implemented in 2001, with new fishery management provisions planned for 2002.
Solomon Islands	22 species	Increase from 15 species in 1988 to 22 species in 1993. Dramatic increase in export from 17 t in 1982 to 622 t in 1991.	50% of exports from western province but populations in severe decline (1992); ban on collection and sale of *H.scabra* in 1997, but locals continue to collect them.
Tanzania	7 primary, 13 additional species	*H. atra* is the most prized species.	Fishery is unregulated.
Thailand	*H. scabra; H. atra H. leucospilota B. marmorata B. argus S. chloronotus; S.variegatus;* and *S. chloronatus*	Decrease in abundance in fished areas.	No management or regulations.
Tonga	*A. mauritiana* (#1); *H.atra* (#2), *S. chloronotus* (#3), *A. lecanora* (#4), *H.fuscogilva*(#5) *S.variegatus* (#6) + 8 other species	Traditional use: commercial fishery began in mid-1980s; increased in 1990 due to unregulated use of scuba and hookah. Recorded exports are 9,767 kg (1991); 35,367 kg (1993); 61,449 kg (1994) and 60,160 kg (1995, 5 months).	Legal minimum sizes for some species; ban on use of scuba and hookah. A ten year ban on take implemented in 1999.
Torres Strait (AUS, PNG)	*H. nobilis* , *H. fuscogilva H. scabra*	*H. nobilis* , *H. fuscogilva* at turn of century; annual catch averaged	Fishery primarily on Warrior reef complex. Australia and PNG cooperate

	Actinopyga spp.	around 500 t; *H. scabra* dominated catch in 1990-1991, but other spp including *Actinopyga* spp. are targeted because *H. scabra* stocks are depleted.	in management, conservation. Australia imposed a minimum size of 18 cm and total catch of 260 t in 1996. The fishery has been closed on the PNG side since 1992.
Tuvalu	*H. fuscogilva*; *T. ananas*; *H. nobilis*; *H. fuscopunctata* & 4 other species	Small fishery between 1979-1982 with exports of 1800 kg in 1979, 805 kg in 1980, 90 kg in 1981, and 198.5 kg in 1982; fishery active between 1993-1995 with exports of over 3000 kg each year. *H. fuscogilva* (50-70% of export) *T. ananas* (14-20% of export); *H. nobilis* (0-10% of export); *H. fuscopunctata* (5-13.4%) 4 other species (2.8-12.8%)	The fishery is not regulated, but there are recommendations to ban use of scuba and hookah gear to harvest sessile organisms including sea cucumbers.
USA	*S. californicus* *S. parvimensis* *C. frondosa* (Maine)	Fishery started in 1970s on the west coast; 1994 in Maine.	Management plan, research, monitoring in place; west coast fishery appears to be sustainable.
Vanuatu		No traditional fishery, but important export product. low population abundance	Annual export limit of 40t established in 1991, but fishers never reach the quota.
Venezuela	*I. badionatus* *H. mexicana*	Fishery began in 1991-1992, but catches were made in a national park and were illegal. In 1993, 4 boats received 1 year licenses each to harvest 200 kg.	Sporadic legal commercial fishing and frequent closures; illegal fishing in parks involving Asian entrepreneurs.

Table 3. Amount of dried sea cucumbers (metric tons) imported into Hong Kong SAR. Source: Hong Kong SAR import statistics. The values with an * represent data from Singapore, Hong Kong SAR and Chinese Taipei. **The Western Indian Ocean countries that export sea cucumbers include South Africa, Mozambique, Tanzania, Kenya, Yemen, United Arab Emirates and Madagascar, some of which are listed separately in subsequent years.

Country	1983	1988	1989	1993	1994	1995	1999	2000	2001
Africa	145.43	0	0						
Australia	0	7.60	1.10					14.19	21.83
Brazil								0	0.45
Canada	0	33.60	15.00					2.69	58.54
Chile								22.32	7.60
China	0	98.50	117.10					13.16	11.78
Columbia								0	0.55
Costa Rica								0.66	0
Cuba								19.02	13.94
Djibouti								0	0.01
Ecuador	0	0	0				112.6	15.28	0.09
Fiji	0	1295.0*	251.0*	119	176	402		364.37	275.54
France								0	0.16
India	0	33.0*	94.0*					0.40	3.81
Indonesia	836.65	3,633.0*	1,987.0*	2620	2599	1694		1007.06	1060.39
Japan	483.98	34.20	39.40					74.94	102.76
Kiribati				99	130			9.07	13.96
Korea	368.26	42.90	22.40					2.54	0
Madagascar	0	86.60	57.70	379	318	170	600	178.39	179.08
Malaysia	0	19.50	125.16	17.50				59.31	66.04
Maldives	0	347.0*	367.0*					39.42	28.76
Mauritius								3.19	0
Mexico								0.15	0.59
Moraco								0	2.24
Mozambique	0	39.10	22.90					0.11	0.95
Netherlands								0	0.01
New Caledonia	0	34.0*	28.0*					0	0
New Zealand								11.04	31.19
Oceania	59.28	0	0					14.19	21.83
Oman								0.96	0.49

Papau New Guinea	0	327.00	226.00	179	150	236		531.90	493.41

Philippines	918.07	1718.50	621.70	1,872	1726	1270	1069.95	736.93
Seychelles							7.12	15.68
Singapore	51.93	797.70	1067.90				345.39	334.81
Solomon Islands	0	139.60	91.50	319	247	161	144.37	259.73
South Africa	0	34.30	22.30	28	93		27.88	28.78
Spain							1.00	0
Sri Lanka	1.30	72.0*	52.0*				64.85	32.90
Swaziland							0.35	0
Chinese Taipei	0	0	0				40.36	56.72
Tanzania	0	61.20	18.30	478	303	257	114.58	56.38
Thailand	0	0	15.50				133.86	101.02
Tonga	0	0.20	0				0	0
Tuvalu	0	0	0		0.871		0	0
United Arab Emirates							10.85	40.62
USA	0	12.10	24.20				181.57	89.74
Vanuatu	0	2.20	0	6	40		28.48	16.35
Vietnam							0.70	3.27
Other	0	151.80	161.70					
Western Indian Ocean Countries*	0	620.0*	470.0*					
Yemen							0	3.20
TOTAL	2125.4	9640.6	5,898.9	6099	5782	4190	4,758.7	4382.3

Table 4. Reported exports of sea cucumbers between 1990-1998. All data are metric tons

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Canada Nova Scotia	0	0	0	0	0	0	0	0	0	3.1	975
Fiji	323.3	319.4	402.8								
Indonesia	3438										
Maldives	551										
Madagascar	202	545	423	356	650	311	320				
Malaysia											
Baja, Mexico	189.2	662	729.4	367	563.1						
Mozambique	500			700		6	54				
New Caledonia	126.6	123.6	80.2	39.5	79.9	48.0	49.2	56.5	39.1		
PNG		626.1	419.5	499.8	207.1	122.8					
Philippines	1218										
Solomon Islands	118.9	622.4									
Tonga		9.8		35.4	61.5	60.2					
Torres Strait						1000		115	115	50	
Tuvalu				0.9	3.7	3.3					

Table 5. Commercial harvest of sea cucumbers in the United States in metric tons (mt), live weight.

	1993	1994	1995	1996	1997	1998	1999	2000	2001
Alaska, Kodiak and Chignik Districts	256.1	187.6	65.8	73.7	60.0	64.6	52.7		64.7
Oregon	2.4	4.8							
California	265.8	293.0	267.6	380.8					
Washington			529	237	227	208			

Table 6. Imports of sea cucumbers by Chinese Taipei . All data are in kg.

Sea cucumber product	source	1999	2000	2001
Live, fresh or chilled	Canada, United States and Japan	210	0	0
Frozen	United States, Canada, Australia, Japan, Yugoslavia, Germany, Croacia, Philippines, Egypt, Ecuador, Chile, Russia, Korea	299,019	294,548	197,881
Spiked, dried	Japan, Russia, Korea, Yugoslavia, Hong Kong SAR, Peru, Australia, United States	37,020	31,881	20,288
Non-spiked, dried	Sri Lanka, Papua New Guinea, Indonesia, India, Madagascar, Singapore, Australia, Mozambique, Hong Kong SAR, Saudi Arabia, Fiji, Tanzania, New Caledonia, Japan	165,898	130,312	155,995
Dried, other	Indonesia, Sri Lanka, India, Papua New Guinea, Australia, Singapore, United States, Japan, Fiji, Mexico, Mozambique, Ecuador, Madagascar, Philippines, Hong Kong SAR, Yemen, Peru, Saudi Arabia, Solomon Islands	324,311	386,375	270,493
Salted or brine	United States, Ecuador, Canada, Singapore	54,457	44,171	31,724

Source Chinese Taipei Customs Statistics

Table 7. Summary of management measures implemented or recommended to promote sustainable sea cucumber fisheries

No-take marine protected areas
Closed season during spawning periods
Rotational harvest
Total allowable catch based on estimated Maximum Sustainable Yield
Minimum size, set above the size at first sexual maturity
Prohibit night fishing for nocturnal species
Baseline surveys of areas to be exploited and field monitoring
Limited entry; restrict harvest to local communities
Improved monitoring of catch data (numbers of individuals harvested, sizes and location of collection) and trade
Logbooks with information on catch location, species composition, method of collection, quantity and destination
Development of associations of licensed exporters to improve reporting of catch and export data and to establish quality standards
Fisheries should be managed by individual species rather than by assemblages of species (e.g., “sea cucumbers”) to avoid declines in CPUE masked by shifts in fishing effort to other less valuable species
Establishment of sea ranching operations
Restocking programs